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Engine Performance and Emission Test of Waste Plastic Pyrolysis Oil, Methanol and Diesel blends with a Cetane Additive AC 2010A on Four Stroke Twin Cylinder Diesel Engine

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ABSTRACT: *In this study, diesel fuel, Methanol and Waste Plastic Pyrolysis oil with an addition of cetane additive blends were tested in a four stroke Twin cylinder diesel engine. The objective of adding Cetane Additive is to improve the combustion of blended fuel and have better performance characteristics for the blend. The Cetane additive addition is as recommended by TOTAL AC2010A. The 1ml cetane additive is added to 1000ml of blended fuel. The main objective of this report is to analyze the fuel consumption and the emission characteristic of a diesel engine which uses waste plastic pyrolysis oil in alternation of an ordinary diesel which are available in the market. Four stroke Twin cylinder diesel engine was used in this study to find out the brake thermal efficiency, specific fuel consumption, and emissions with the fuel of fraction methanol and Waste plastic pyrolysis oil in diesel. In this study, the diesel engine was tested using methanol and waste plastic pyrolysis oil blended with diesel at certain mixing ratio of 5:5:90, 10:10:80 and 15:15:70 of methanol and waste plastic pyrolysis oil to diesel respectively. Experimental results of blended fuel and diesel fuel are also compared.*

KEYWORDS *- Alternative Fuel, Cetane Additive, Methanol, Waste Plastic Pyrolysis Oil (WPPO)*

I. INTRODUCTION

The Conversion of Waste to energy is the recent trend in the selection of alternate fuels. The Fuels like alcohol, biodiesel, liquid fuel from plastics are some of the alternative fuels for the internal combustion engines. Plastics have become an indispensable part in today's world, due to their lightweight, energy efficiency, coupled with a faster rate of production and design flexibility; these plastics are employed in both industrial and domestic areas. But plastics have become essential materials and their applications in the industrial field are continually increasing. Plastics can be used as an alternative source of fuel for the diesel engines. The production of fuel from the plastics can be obtained in the form of the pyrolysis process. The objective of this report is to analyze the fuel consumption and the emission characteristics of a kirloskar twin cylinder diesel engine. This report describes the setups and the procedures for the experiment which is to analyze the emission characteristics and fuel consumption of diesel engine due to usage of both fuels. In this study, the diesel engine was tested using methanol and waste plastic pyrolysis oil blended with diesel at certain mixing ratio of 5:5:90, 10:10:80 and 15:15:70 of methanol and waste plastic pyrolysis oil to diesel respectively. We found that the blends gives closer values to Diesel fuel in the Twin cylinder Diesel engine, without any further modification in the engine itself.

II. WASTE PLASTIC PYROLYSIS OIL

Pyrolysis is a form of treatment that chemically decomposes organic materials by heat in the absence of oxygen. The word is originally coined from the Greek-derived elements pyro "fire" and lysys "decomposition". Waste plastic pyrolysis oil involves subjecting plastic to high temperature of 300 to 350 degree Celsius, in absence of oxygen. In case of oxygen is present then plastic will start burning. The plastic waste is gently cracked by adding catalyst and the gases are condensed in a series of condensers to give a low sulphur content distillate. All this happens continuously to convert the waste plastics into fuel oil. During waste plastic pyrolysis, plastic breaks down into smaller molecules of pyrolysis oil, pyrolysis gas and carbon black. The catalyst used in this system will prevent formation of all the dioxins and Furans(Benzene ring). All the gases from this process are treated before it is let out in atmosphere. The flue gas is treated through scrubbers and water/ chemical treatment for neutralization.

III. PROPERTIES OF FUELS

Properties of Diesel, Methanol, Waste Plastic Pyrolysis Oil:

S.No	Properties	Diesel	Methanol	WPPO
1	Density	850	796.6	793
2	Kinematic Viscosity @ 40Deg. C (cst)	3.05		2.149
3	Cetane Number	55	4	51
4	Flash Point °C	50	12	40
5	Fire Point °C	56	97.6	45
6	Carbon Residue (%)	0.20 %		0.01 %
7	Sulphur (%)	<0.035		<0.002

Table 1

Properties of Blended Fuels:

Blended fuel in the mixing ratio of Methanol 10% / WPPO 10% / Diesel 80% was tested at Italab Private Limited, Parrys, Chennai, India.

Again Blended fuel in the mixing ratio of Methanol 10% / WPPO 10% / Diesel 80% / Cetane Additive was tested at Italab Private Limited, Parrys, Chennai, India.

S.No	Properties	M/WPPO/D	M/WPPO/D + Cetane Additive
1	Kinematic Viscosity @ 40Deg. C (cst)	2.47	2.47
2	Cetane Number	47	49
3	Carbon Residue (%)	0.01 %	0.01 %
4	Sulphur (%)	0.05 %	0.05 %

Table 2

IV. EXPERIMENTAL SETUP

The experimental setup consists of a four stroke twin cylinder diesel engine, a gas analyzer and smoke tester. The engine is water cooled and cranks start. The load applied on the engine is by means of electric loading device.

Engine Specifications:

Engine Make	Kirloskar
Engine Type	Four stroke Twin cylinder diesel engine
No. of cylinders	2
Stroke	110mm
Bore	87.5mm
Method of cooling	Water cooled
Horse power HP	10HP
Type of starting	Crank start
Lubrication	Forced
Compression ratio	17.5:1
Load type	Electric load bank

Table 3

V. RESULTS AND DISCUSSIONS

The Performance and emission test of Waste Plastic Pyrolysis oil, Methanol, Diesel with a Cetane Additive with different ratios of blends are discussed below.

Specific Fuel Consumption (SFC): In the Figure 5.1, the variation of SFC for different loads (KW) with respect to different ratios of Fuel blends. The blended fuel SFC of is marginally higher than diesel oil. The M5/WPP5/D90 and cetane additive blend has the SFC values are much closer to diesel.

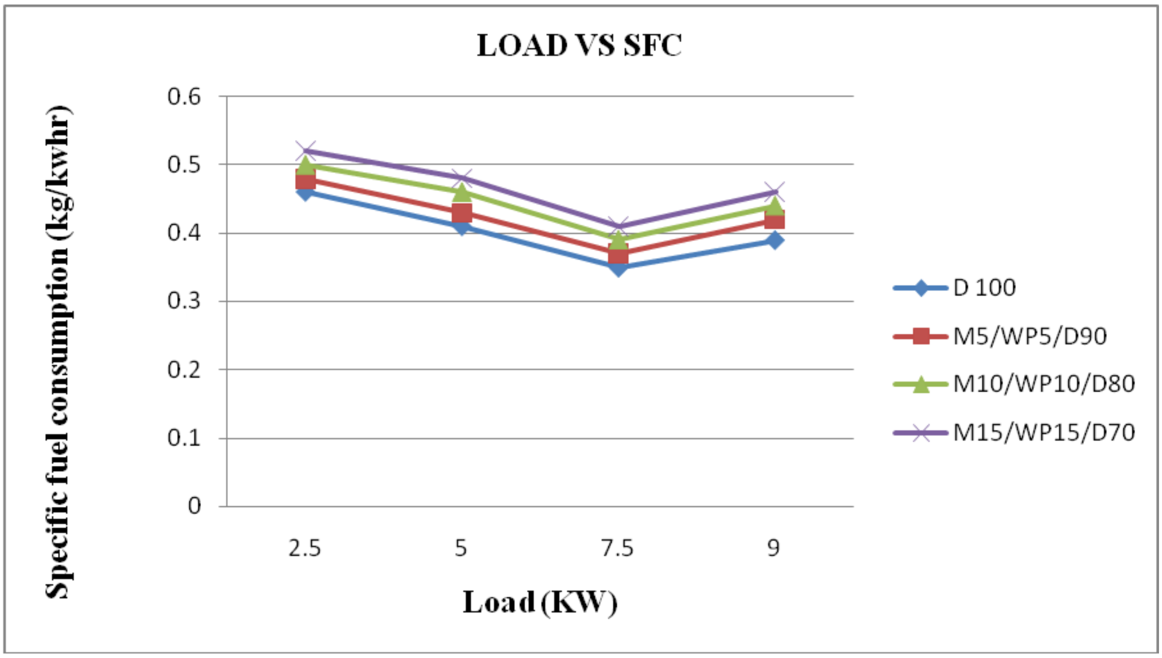

Fig. 5.1 Variation of SFC (kg/kwhr) with Load (Kw)

Brake Thermal Efficiency: In Figure 5.2, the variations of the brake thermal efficiency for various load with respect to different ratios of blends. In this the brake thermal efficiency of blended fuel is slightly lower than diesel oil. The M5/WPP5/D90 blend has brake thermal efficiency values closer to diesel.

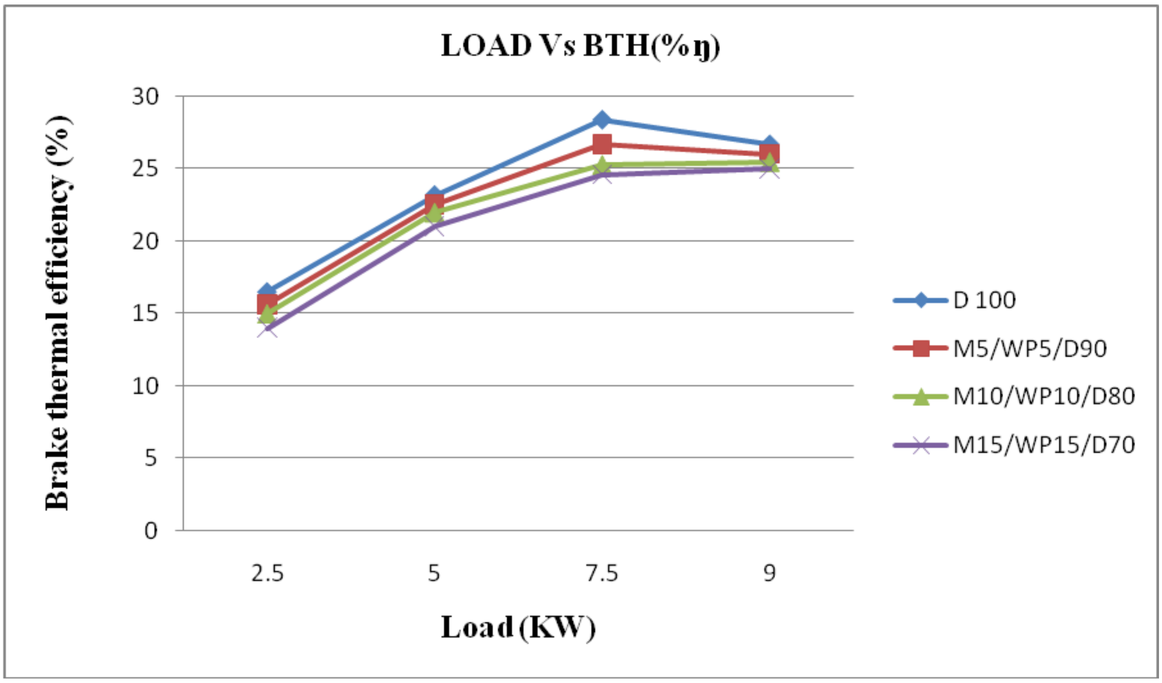

Fig. 5.2 Variation of brake thermal efficiency (%) with Load (Kw)

Carbon monoxide Emission (CO): In Figure 5.3, the variation of CO emission levels for various loads with respect to different ratios of blends are shown. From the figure it is concluded that CO emission level is similar to that of Diesel.

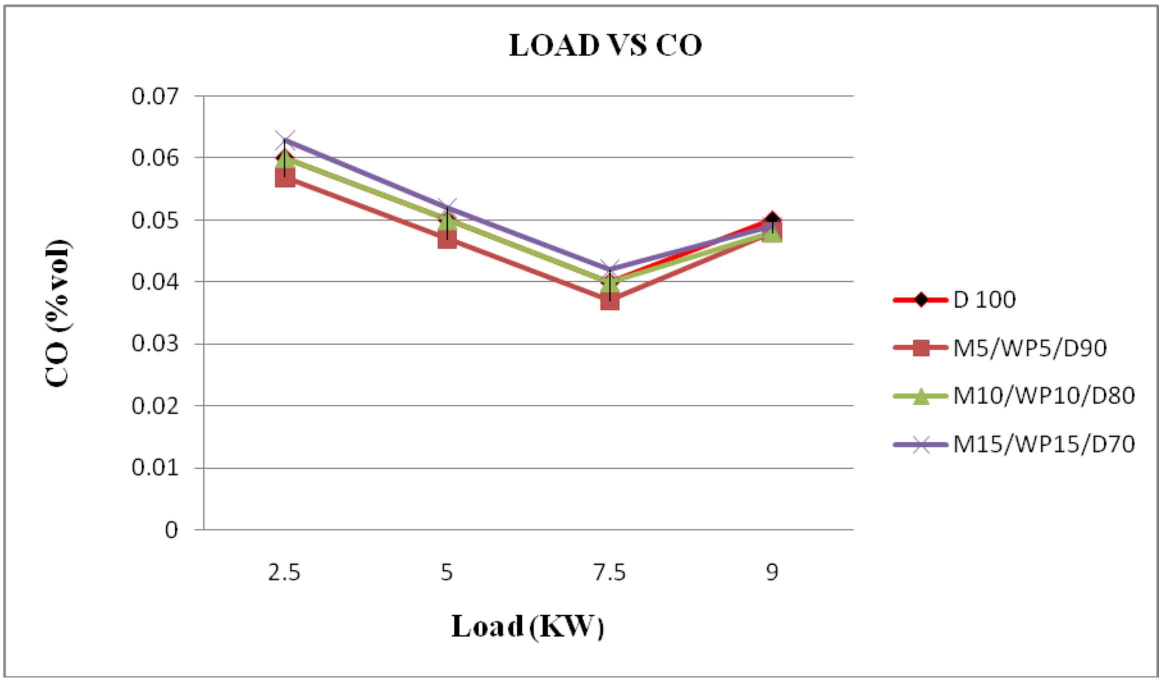

Fig. 5.3 Variation of CO (% vol) with Load (Kw)

Carbon dioxide Emission (CO_2): In Figure 5.4, the variations of CO_2 emission levels for various loads with respect different ratios of blends are shown. From the figure it is concluded that CO_2 emission level is closer to Diesel.

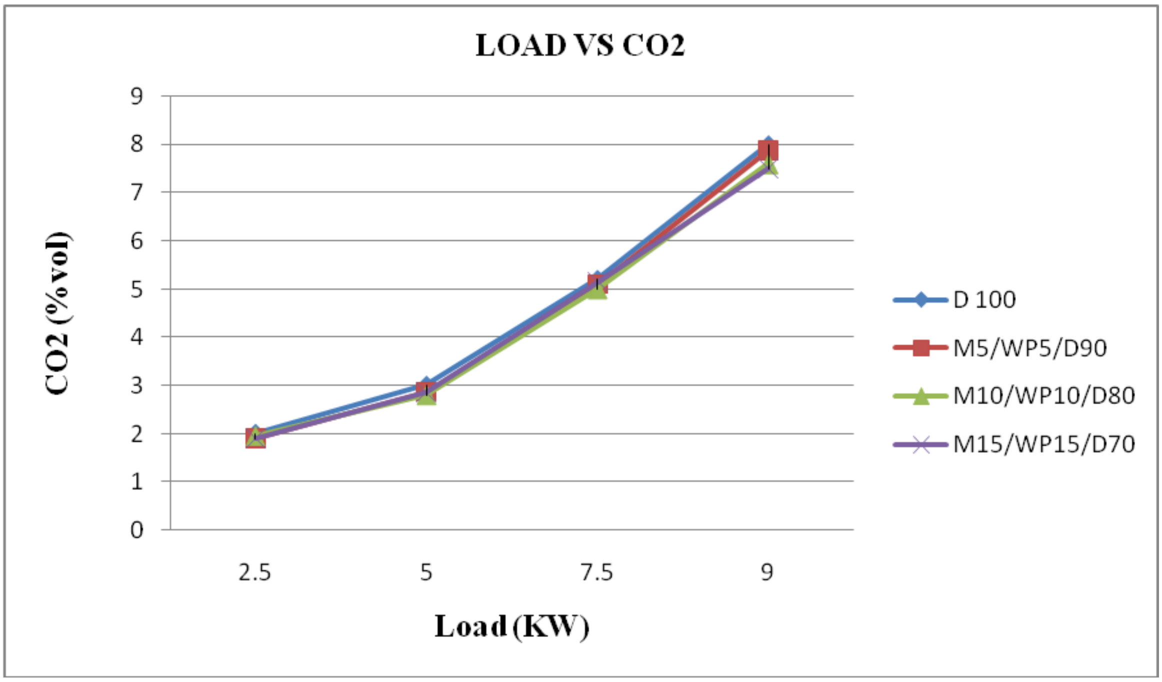

Fig. 5.4 Variation of CO2 (%vol) with Load (Kw)

Hydrocarbon Emission (HC): In Figure 5.5, the variations of HC emission levels for various loads with respect different ratios of blends are shown. From the figure it is concluded that HC emission is near to that of Diesel. But in higher loads the HC emissions are slightly lower than diesel.

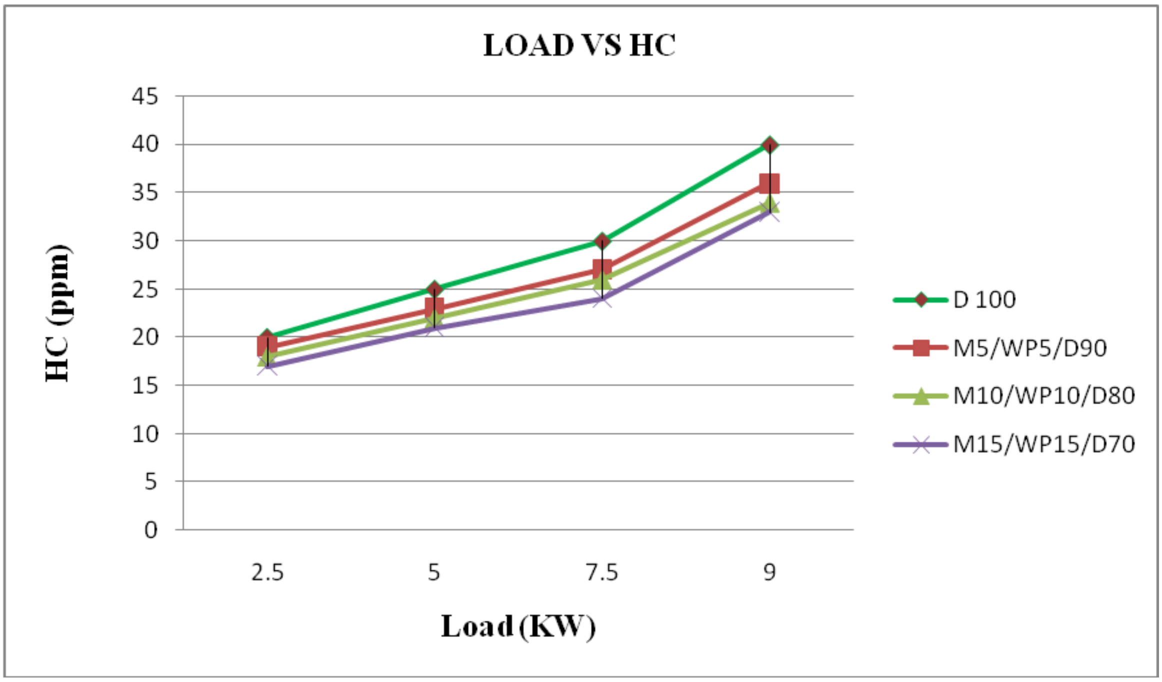

Fig. 5.5 Variation of HC (ppm) With Load (Kw)

Nitrogen Oxide Emission (NOx): In Figure 5.6, the variation of NO_x emission level for various loads with respect to different ratios of blends. The NOx emissions from different ratios of the blends are slightly higher than the normal diesel fuel for all the loads.

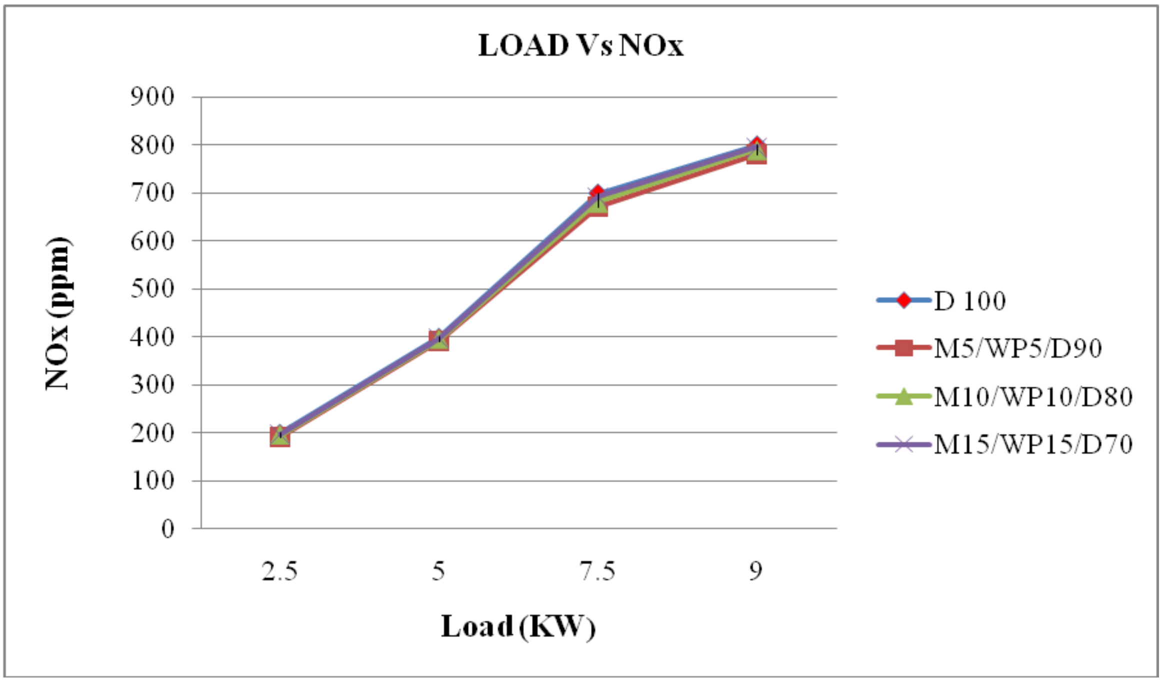

Figure 5.6 Variation of NOx (ppm) with Load (Kw)

VI. CONCLUSION

After conducting the experiment on Waste Plastic Oil, Methanol and Diesel blends with cetane Additive, it is concluded that this blend represents a good alternative fuel which gives good performance and better emission characteristics. The Waste Plastic Pyrolysis Oil 5%, Methanol 5% and diesel 90% blends with Cetane Improver gives good performance when comparing to the other blends.

NOMENCLATURE

CO	Carbon Mono-oxide
CO_2	Carbon di-oxide
HC	Hydrocarbon
NOx	Nitrogen Oxide
BTH	Brake Thermal Efficiency
SFC	Specific fuel consumption
WPPO	Waste Plastic Pyrolysis Oil
M/WPPO/D	Diesel/Methanol/Waste Plastic Pyrolysis blend oil
M/WPPO/D + Cetane Additive	Diesel/Methanol/Waste Plastic Pyrolysis blend oil + Cetane Additive

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